LaTeX
Zen and the Art of Scientific Manuscript Production

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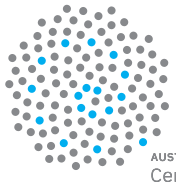

AUSTRALIAN RESEARCH COUNCIL
Centre of Excellence for Mathematics
and Statistics of Complex Systems

Talk outline

What is LaTeX?

Definition

A computer system for typesetting (complicated) documents

Typewriter $\longrightarrow$ designer $\longrightarrow$ typesetter $\longrightarrow$ printer
Text (content) $\longrightarrow$ design and implement $\longrightarrow$ what we see and read

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- LaTeX is a document 'design' language (high level)

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A computer system for typesetting (complicated) documents

Typewriter $\longrightarrow$ designer $\longrightarrow$ typesetter $\longrightarrow$ printer
Text (content) $\longrightarrow$ design and implement $\longrightarrow$ what we see and read

- LaTeX is a document 'design' language (high level)
- LaTeX is built on TeX — a typesetting language (low level)
- Similar idea to HTML (more powerful than HTML)

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How do we use it?

- To use LaTeX one creates a "text" file which contains text + design (and some typesetting) instructions

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How do we use it?

- To use LaTeX one creates a "text" file which contains text + design (and some typesetting) instructions
- One then *compiles* this file to obtain the formatted version which can be sent to a printer

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- All you need worry about is content (mostly).

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- LaTeX frees you from worrying too much about formatting as it is a high level formatting language based on *logical design*
- All you need worry about is content (mostly).
- LaTeX vs TeX = broad design vs nuts-and-bolts (high vs low)
- WYSIWYG apps rely on *visual design* vs LaTeX's *logical design*

Some examples of logical design

Example 1:

Say you want to add some poetry to your document. In LaTeX there is a `verse` environment that lets you tell LaTeX that the text inside some part of your document is poetry and LaTeX will then indent it (etc) so it stands out correctly.

$\Rightarrow$ automatic formatting

Some examples of logical design

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Example 2:

Say you want to use an inner product in your document, as in (A, B) you can write a macro (i.e. a definition)

```
\ip
```

that gives you (A, B) whenever you type it. This allows you to change (A, B) to (ϕ, Γ) or even $[\phi, \Gamma]$ whenever you want throughout your document.

$\Rightarrow$ Easy to make global changes

Some examples of logical design

Example 3: Proper typesetting

Ligatures — the letters f and l put together give fl
not like g and c which become gc

$\Rightarrow$ fancy typesetting built-in

Some examples of logical design

Example 3: Proper typesetting

Ligatures — the letters *f* and *l* put together give *fl*
not like *g* and *c* which become *gc*
⇒ fancy typesetting built-in

Example 4: More proper typesetting

Dashes — there are 3 different dashes:
1 dash as in `inter-word` gives inter-word ,
2 for number range `10--90` giving 10–90,
and 3 for sentence punctuation as in
`Dashes --- there are 3 different dashes`
gives the beginning of this sentence.

Some more examples of logical design

Example 5: lists

```
\begin{enumerate}

   \item a list of lists
   \item \begin{itemize}

           \item list 1
           \item list 2
           \item list 3

         \end{itemize}
   \item another item

 \end{enumerate}
```

Some more examples of logical design

Example 5: lists

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\begin{enumerate}
   \item a list of lists
   \item \begin{itemize}
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   \item another item
\end{enumerate}
```

1. a list of lists
2.
   - list 1
   - list 2
   - list 3
3. another item

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- Mathematical typesetting ($\mathcal{AMS}$-LaTeX packages)
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- It's free!
- Lots of add-ons: (Comprehensive TeX Archive = CTAN)
- Department standard = lots of expertise

Right tool for the job

The right tool for theses

In the end you should use the *right tool for the job*. Thesis and journal articles in mathematics are highly structured documents with lots of sections and subsections, cross references, mathematics and citations.

All this means that using LaTeX is the way-to-go!

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- Leslie Lamport started distributing LaTeX2.09 in 1985
- CTAN started in 1986
- The current LaTeX 2_ε was distributed in 1994 (backward compatible with LaTeX2.09 mostly)
- Development is continuing in the LaTeX3 project
- Lots of new packages since then though (eg. Beamer)
- Compare time-span between major changes in Word or Wordperfect etc

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- Loads of documentation locally comes with the teTeX distribution which is installed on `digican`. This documentation can be accessed easily from http://www.it.ms.unimelb.edu.au/tex/index.html

Useful web sites

- http://www.latex-project.org
- http://www.ctan.org
- mirror.aarnet.edu.au/pub/CTAN/help/Catalogue/index.html
- http://www.tex.ac.uk
- http://www.tug.org
- http://ms.unimelb.edu.au/~aleks/latex-talk.html

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8. If you use BibTeX also compile the file using BibTeX after the first 'latex-ing' and then compile twice more.

On digican I

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Don't worry the compilation is *fast...*

The command `latex` generates `myfirst.aux`, `myfirst.log` and most importantly the `myfirst.dvi`, the 'device independent' file.

Compile frequently. Remove .aux file if stuck.

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or a PDF document

```
Euler@digican> dvipdf myfirst.dvi
```

Note that the command `pdflatex` produces pdf directly

TeXShop on a OS X Mac

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5. displays PDF automatically

Basic structure of a LaTeX document

```
\documentclass{the type of document}
```

After this is the the rest of the *preamble*, which is setting up the document, eg macros such as `\ip`, double-spacing, adding extension packages etc.

```
\begin{document}
    A structured document
\end{document}
```

Document classes

Some document classes are

- `article`
- `report`
- `book`
- `letter`
- `slides`
- `seminar`
- `prosper`
- `beamer`

Theses in the department can be written under `report` or `book` but other classes have written like various specific `thesis` and alternative `letter` classes.
A more sophisticated talk environment (*this one!*) uses `beamer`

Three types of LaTeX structure I

The pair

```
\begin{some formatting environment}
\end{some formatting environment}
```

Three types of LaTeX structure I

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```
\begin{some formatting environment}
\end{some formatting environment}
```

Example:

```
\begin{equation}
x^n + y^n = z^n
\end{equation}
```

gives

$$x^n + y^n = z^n \tag{1}$$

Three types of LaTeX structure II

The formatting command

```
\do-this{to this input}
```

Three types of LaTeX structure II

The formatting command
`\do-this{to this input}`
Example:
`\textbf{I am bold}` makes the text contained with boldface such as
I am bold

Three types of LaTeX structure III

The command

`\just-do-this-now`

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Examples
`\pounds` gives us the pound symbol £

Three types of LaTeX structure III

The command

`\just-do-this-now`

Examples

`\pounds` gives us the pound symbol £

`{1st-text \large 2nd-text}` makes the 2nd-text larger, as in 1st-text 2nd-text

Special characters

Hence there are some *special* characters in LaTeX
These are \ ^ ~ { } _ & % $ #

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Examples:

```
\documentclass[11pt,a4paper]{article}
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Sometimes formatting commands take multiple arguments inside more than one set of {} or parameters inside []
Examples:

```
\documentclass[11pt,a4paper]{article}
\newcommand{\ip}{[\phi,\Gamma]}
```

The preamble

```
% lines beginning with % are comments
%%%%%%% what kind of document are we writing %%%%%%%%
\documentclass[11pt,a4paper]{article}

%%%%%%% inclusion of latex 2e packages or extensions %
\usepackage{\graphicx,amsmath,amsfonts,amsthm}

%%%%%%%%%% setting up or modifying the page %%%%%%%%%%
% this is a low level command (unusual LaTeX syntax)
\textheight=24cm

% To change the spacing edit here!
\renewcommand{\baselinestretch}{1.3}

% AMS latex command for changing equation numbering
% inside sections
\numberwithin{equation}{section}

%%%%%%%%%% ************ Macros ************ %%%%%%%
\newcommand{\mymacro}{\hat{\varphi}^{(n)}}
\newcommand{\ip}{[\phi,\Gamma]}

% this defines a theorem environment,
% numbered by section, called thm
\newtheorem{thm}{Theorem}[section]
```

Firstly: The title page or section

```
\begin{document}
\title{My new manuscript}
\author{A. L. Owczarek \\
Department of Mathematics and Statistics, \\
The University of Melbourne, \\
Victoria 3010, Australia.}
\date{
\begin{center}
 \today
\end{center}
}

\maketitle
\begin{abstract}

This is interesting article about knots and G\"{o}del.
\end{abstract}
```

The main contents

```
\section{Introduction}
Here we explain why everyone that has gone before is so
insignificant compared to the intellectual leap
this article is about to unveil. We need to have a
second     sentence.


\section{The methods} \label{methods}
Similarly, staircase polygons with staircase holes
were also
investigated.  Topologically, the objects look
like the cross section
of a slab of Emmenthaler cheese or foam
rubber.  There is a boundary
polygon, containing disjoint polygons which
don't touch the boundary.
It was shown that, with a finite number of
holes, the connective
constant is unchanged for any finite
number of holes.
```

More contents

```
\section{Results}
We are just so clever for thinking like this

in section \ref{methods}. In an earlier  paper
\cite{guttmann1998} the problem of \emph{punctured polygons}
was studied.

\section*{Acknowledgements}
I would like to thank my family and the members of
the Academy of Motion Pictures.
```

References

```
%% References

\bibliography{my-bibliographic-database}
\bibliographystyle{unsrt}
```

This tells LaTeX that you keep a bibliographic database called my-bibliographic-database.bib.
LaTeX searches for all citations you made: eg \cite{guttmann1998}by looking up the 'keys' eg.guttmann1998 in your .bib file
LaTeX creates a file called my myfirst.bbl with the actual bibliography for myfirst.tex (and a log file myfirst.blg)

my-bibliographic-database.bib

One of the entries in this file looks like

```
@article{guttmann1998,
author="A. J. Guttmann and A.  L. Owczarek and X. G. Viennot",
title="Vicious walkers and Young tableaux: Without walls",
journal="J. Phys. A.",
volume=31,
year=1998,
pages="8123--8135"
}
```

Inclusion of Encapsulated postscript figures

Use graphics or graphicx packages by putting
\usepackage{graphicx}
in the preamble
then add in the main text

```
\begin{figure}[ht]
\begin{center}
\includegraphics[width=12cm]{picture.eps}
\caption{\textit{A caption explaining the figure.}}
\label{myfig1}
\end{center}
\end{figure}
```

close to where you first cite the figure with

```
We show this  in figure~\ref{myfig1}
```

How do I make the postscript figures

Macromedia Freehand for Macintosh or xfig for Unix/X11 are good also for producing single "vector" drawings, as many mathematical subjects call for, and can output to encapsulated postscript (for inclusion in LaTeX documents). LaTeX has some basic "vector" drawing capabilities builtin.
Other applications such as gnuplot, Mathematica, Maple etc can produce postscript output.
Can include other types of figure, eg jpeg, pdf

Equations

There are two major types of equation:
1. 'Displayed' equations
2. 'In-line' equations

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There are several environments for producing displayed equations some with numbering, some without, some for multiline equations and some for single lines.

Equations: Displayed

For single line equations with numbering you can use

```
\begin{equation}
\sum_{k=0}^{\infty}
\left( \frac{\Gamma(z_k)}{\Phi(z_k)} + 1 \right)
= \oint d\theta \: e^{2\pi i \theta}
\end{equation}
```

$$\sum_{k=0}^{\infty} \left(\frac{\Gamma(z_k)}{\Phi(z_k)} + 1 \right) = \oint d\theta \, e^{2\pi i \theta} \tag{2}$$

Arrays of equations

Without using the $\mathcal{AMS}$-LaTeXpackage one can use `eqnarray`

```
\begin{eqnarray}
Z &=  & \int_0^\infty \phi(x)  \; dx \nonumber \\
 &=  &  \frac{\partial F(y,0)}{\partial y}
\end{eqnarray}
```

giving

$$\begin{aligned} Z &= \int_0^\infty \phi(x)\, dx \\ &= \frac{\partial F(y,0)}{\partial y} \end{aligned} \tag{3}$$

In $\mathcal{AMS}$-LaTeXpackage there is the `align` and the `cases` environments (as well as many others).

Equations: Inline

Consider the same equation displayed in-line 'encased' by $ and $

```
We have $ \sum_{k=0}^{\infty}
\left( \Gamma(z_k)/\Phi(z_k) + 1 \right)
= \oint d\theta \: e^{2\pi i \theta}$.
Usually only smaller  equations like
$\Gamma(z_i)=1/2$ would be displayed inline.
```

We have $\sum_{k=0}^{\infty} \left(\Gamma(z_k)/\Phi(z_k) + 1 \right) = \oint d\theta \: e^{2\pi i \theta}$. Usually only smaller equations like $\Gamma(z_i) = 1/2$ would be displayed inline.

Tables: tabular environment

```
\begin{tabular}{|r|l|c|}\hline
First Name & Surname & Favourite Equation\\
\hline
John & Tuttle & $\nabla^2 \phi=0$\\
Benjamin & Owczarek & $1+1=2$ \\
Tony & Blair & $e^{2\pi i} =1 $\\
\hline\hline
\end{tabular}
```

gives

First Name	Surname	Favourite Equation
John	Tuttle	$\nabla^2 \phi = 0$
Benjamin	Owczarek	$1 + 1 = 2$
Tony	Blair	$e^{2\pi i} = 1$

Tables: a referenced table

One can put the tabular environment inside a table or figure

```
\begin{table}
\centering
\begin{tabular}{|r|l|c|}\hline
First Name & Surname & Favourite Equation \\
\hline
John & Tuttle & $\nabla^2 \phi=0$ \\
Benjamin & Owczarek & $1+1=2$ \\
Tony & Blair & $e^{2\pi i} =1 $\\
\hline\hline
\end{tabular}
\caption{A table of people}
\label{tab:names}

\end{table}
```

First Name	Surname	Favourite Equation
John	Tuttle	$\nabla^2\phi = 0$
Benjamin	Owczarek	$1 + 1 = 2$
Tony	Blair	$e^{2\pi i} = 1$

Table: A table of people

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- The package `pstricks` is popular for making lots of postscript figure manipulations and creations
- I find `rotating` good for rotating tables
- If you need to you can use LaTeX to write music or Feynman diagrams (both have packages!).

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- LaTeX may change the way you look at typeset documents forever.
- At the very least it will help get you through your honours or postgrad degree in maths.
- These slides, links and some other material can be found at `http://ms.unimelb.edu.au/~aleks/latex-talk.html`
- Try modifying some of these or someone elses and then create your own with the LaTeX book nearby.
- Enjoy producing beautifully typeset documents
  — Impress your friends and family ;-)